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- [c9] The steam reforming process of claim 1 further comprising cooling the syngas effluent stream and taking the recycle gas from the cooled syngas effluent stream.
- [c10] The steam reforming process of claim 9 wherein the syngas effluent stream is cooled in a waste heat boiler.
- [c11] The steam reforming process of claim 9 wherein the syngas effluent stream is cooled in a reforming exchanger.
- [c12] The steam reforming process of claim 1 wherein the ratio of recycle gas to gas feed stream is from 0.3 to 0.7 and the feed mixture comprises from 20 to 40 mole percent hydrogen.
- [c13] A steam reforming process, comprising:  
 heating first and second gas feed streams comprising a raw mixture of hydrocarbon and steam;  
 heating a third stream comprising oxidant gas;  
 supplying the first heated gas feed stream in a feed line to an autothermal reformer with the third stream in an oxidant supply line;  
 recovering a first syngas effluent stream from the autothermal reformer;  
 supplying the second heated stream to a reforming exchanger for endothermic catalytic conversion in tubes in the reforming exchanger to form a second syngas effluent stream;  
 mixing the first syngas effluent with the second syngas effluent to form a syngas mixture;  
 passing the syngas mixture across the tubes in the reforming exchanger in heat exchange therewith to supply a cooled syngas product to a syngas product line;  
 introducing a portion of the syngas product as recycle gas into the first gas feed stream at a thermo-compressor ejector positioned in the feed line using the first gas feed stream as motive fluid to obtain a feed mixture comprising hydrogen;  
 wherein a ratio of recycle gas to motive fluid is from 0.2 to 1;  
 operating the autothermal reformer at a steam to carbon ratio less than

## 3.6.

- [c14] The steam reforming process of claim 13 wherein the recycle gas is introduced at a thermo-compressor ejector positioned in the feed line using the gas feed stream as motive fluid.
- [c15] The steam reforming process of claim 13 wherein the recycle gas is at a higher temperature than the heated gas feed stream.
- [c16] The steam reforming process of claim 13 wherein the hydrocarbon comprises natural gas.
- [c17] The steam reforming process of claim 13 wherein the oxidant gas is selected from oxygen, oxygen-enriched air and air.
- [c18] The steam reforming process of claim 13 wherein the third stream includes steam.
- [c19] The steam reforming process of claim 13 wherein the feed mixture comprises from 5 to 50 mole percent hydrogen.
- [c20] The steam reforming process of claim 13 wherein the raw mixture has a steam to carbon ratio from 0.6 to 3.
- [c21] The steam reforming process of claim 20 wherein the ratio of recycle gas to motive fluid is from 0.3 to 0.7 and the feed mixture comprises from 20 to 40 mole percent hydrogen.
- [c22] Apparatus for steam reforming, comprising:
- means for heating a gas feed stream comprising a raw mixture of hydrocarbon and steam;
  - means for heating a second stream comprising oxidant gas;
  - means for supplying the heated gas feed stream in a feed line to an autothermal reformer with the second stream in an oxidant supply line;
  - means for recovering a syngas effluent stream from the autothermal reformer;
  - means for introducing a portion of the syngas effluent stream as recycle

gas into the gas feed stream at a thermo-compressor ejector positioned in the feed line using the gas feed stream as motive fluid to obtain a feed mixture comprising hydrogen, wherein a ratio of recycle gas to motive fluid is from 0.2 to 1;  
means for operating the autothermal reformer at a steam to carbon ratio less than 3.6.

- [c23] 1.23.The apparatus of claim 22 wherein the hydrocarbon comprises natural gas.
- [c24] The apparatus of claim 22 wherein the oxidant gas is selected from oxygen, oxygen-enriched air and air.
- [c25] The apparatus of claim 22 wherein the second stream includes steam.
- [c26] The apparatus of claim 22 wherein the feed mixture comprises from 5 to 50 mole percent hydrogen.
- [c27] The apparatus of claim 22 wherein the raw mixture has a steam to carbon ratio from 0.6 to 3.
- [c28] The apparatus of claim 22 further comprising means for cooling the syngas effluent stream and means for taking the recycle gas from the cooled syngas effluent stream.
- [c29] The apparatus of claim 28 wherein the syngas effluent stream cooling means comprises a waste heat boiler.
- [c30] The apparatus of claim 28 wherein the syngas effluent stream cooling means comprises a reforming exchanger.
- [c31] The apparatus of claim 22 wherein the ratio of recycle gas to motive fluid is from 0.3 to 0.7 and the feed mixture comprises from 20 to 40 mole percent hydrogen.
- [c32] Apparatus for steam reforming, comprising:  
means for heating first and second gas feed streams comprising a raw mixture of hydrocarbon and steam;  
means for heating a third stream comprising oxidant gas;

means for supplying the first heated gas feed stream in a feed line to an autothermal reformer with the third stream in an oxidant supply line;  
means for recovering a first syngas effluent stream from the autothermal reformer;  
means for supplying the second heated stream to a reforming exchanger for endothermic catalytic conversion in tubes in the reforming exchanger to form a second syngas effluent stream;  
means for mixing the first syngas effluent with the second syngas effluent to form a syngas mixture;  
means for passing the syngas mixture across the tubes in the reforming exchanger in heat exchange therewith to supply a cooled syngas product to a syngas product line;  
means for introducing a portion of the syngas product as recycle gas into the first gas feed stream at a thermo-compressor ejector positioned in the feed line using the first gas feed stream as motive fluid to obtain a feed mixture comprising hydrogen, wherein a ratio of recycle gas to motive fluid is from 0.2 to 1;  
means for operating the autothermal reformer at a steam to carbon ratio less than 3.6.

- [c33] The apparatus of claim 32 wherein the hydrocarbon comprises natural gas.
- [c34] The apparatus of claim 32 wherein the oxidant gas is selected from oxygen, oxygen-enriched air and air.
- [c35] The apparatus of claim 34 wherein the third stream includes steam.
- [c36] The apparatus of claim 32 wherein the feed mixture comprises from 5 to 50 mole percent hydrogen.
- [c37] The apparatus of claim 32 wherein the raw mixture has a steam to carbon ratio from 0.6 to 3.
- [c38] The apparatus of claim 37 wherein the ratio of recycle gas to motive fluid is from 0.3 to 0.7 and the feed mixture comprises from 20 to 40 mole percent hydrogen.

[c39] A method for starting up the apparatus of claim 28 for continuous operation, comprising the steps of:

- (a) heating the first and second gas feed streams before starting the third stream, wherein the first and second feed streams are essentially free of added hydrogen;
- (b) introducing a hydrogen-generating compound into the first stream, second stream, or a combination of said first and second streams, that is decomposed in the autothermal reformer, reforming exchanger, or combination thereof, respectively, to form hydrogen gas;
- (c) recycling the syngas product from the reforming exchanger into the first gas feed stream;
- (d) when the first gas feed stream reaches or exceeds its minimum auto-ignition temperature at the autothermal reformer inlet, starting the third stream to obtain auto-ignition in the autothermal reformer;
- (e) after the auto-ignition is established, terminating step (b).